Understanding Electrostatic Field Sensing With Graphene: A Miniature And Versatile Alternative To Standard Technologies

Jules Maistret[1,2]

Pierre Lavenus[1], Philippe Molinié[2]

[1] *DPHY, ONERA, Université Paris-Saclay, 92320, Châtillon, France*

[2] *Laboratoire de Génie Électrique et Électronique de Paris, Université Paris-Saclay, CentraleSupélec, CNRS, Sorbonne Université, 91192, Gif-sur-Yvette, France*

jules.maistret@onera.fr

Electric field measurement is becoming of primary importance in various domains, for both civil and military applications, such as early prediction of lightning or prevention of electrostatic discharges on satellites. None of the state-of-the-art electric field sensors combines *good resolution* – which should be below 1 V/m for the aforementioned targeted applications –, with a *high measurement range* – which should be at least 1 MV/m – and *compacity*. Following the use of graphene field effect transistors (GFETs) for gas, pH and various biological sensors, a new concept for an electrostatic field sensor, also based on a GFET, has emerged [1-2]. It has however attracted very little attention by the scientific community and its detection mechanism remains controversial. Here, we propose a physical model of a highly sensitive electric field sensor based on a GFET with a floating gate acting as an antenna. This model, based on the combination of the so-called graphene's transistor effect [3] and the laws describing the potential of a floating conductor, is demonstrated using transistors made of graphene grown by chemical vapor deposition on a SiO_2/Si substrate [4].

References

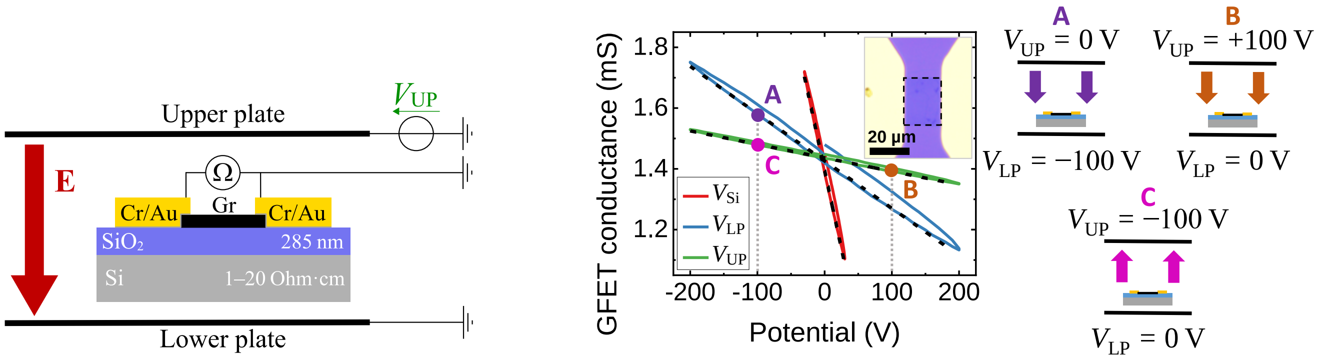
[1] W. Wang *et al.*, *IEEE Electron Device Lett.*, 38(8) (2017), p. 1136-1138.

[2] A. Kareekunnan *et al.*, *ACS Omega*, 6(49) (2021), p. 34086-34091.

[3] K. S. Novoselov *et al.*, *Science*, 306(5696) (2004), p. 666-669.

[4] J. Maistret et P. Lavenus, *2024 IEEE SENSORS* (2024), p. 1-4.

Figures



(a) (b)

Figure 1: (a) Schematic representation of the graphene field-effect transistor in the test bench composed of two metallic plates facing each other to generate an electric field. (b) Graphene drain-source conductance as a function of silicon potential (red), lower plate potential (blue) and upper plate potential (green). The inset shows an optical microscope image of the graphene strip. On the right, configurations corresponding to the points A, B and C.